Steel Construction: Fabrication - Welding

Scope Statement

Ensure the Contractor's Quality Control Inspector uses visual inspection and nondestructive testing techniques to guarantee the preparation, procedure, workmanship, and documentation of all fillet and groove welds.

Quality Assurance performed by the Department may include verification of any or all steps marked "QA." Quality Assurance may order back-up radiographs as determined by the Materials Engineer.

Procedure

Regularly observe welding operations to evaluate workmanship (i.e., size of pass, cleanliness between joints, etc.) and order recertification whenever quality is questionable.

At least once a week, confirm that specified process variables (including volts, amps, wire type, flux, travel speed, and position are maintained (QC/QA).

Appendices A and B detail the procedure for conducting magnetic particle and dye penetrant testing.

OC/OA

- 1. Prior to welding, check the joint alignment and verify joint dimension, cleanliness, and absence of parent metal defects. Ensure that proper pre-heat procedures have been used.
- 2. Verify that all welders assigned to the project are properly certified.
- 3. Inspect the size of each fillet weld using a weld gage.
- 4. Ensure that all welds made correspond to those indicated on the approved shop drawing.
- 5. Visually inspect all finished fillet welds for porosity, uneven legs, cold lap, undercut, and cracking. Ensure that any defective weld is repaired. Order nondestructive magnetic particle or dye penetrant testing when any weld's general quality is suspect.
- 6. Visually inspect all final groove welds for surface roughness, slope of transition, over-grinding, and mismatching.
- 7. Conduct ultrasonic tests to inspect groove welds in main members (in accordance with AWS D1.5 except that the acceptance/rejection criteria must agree with Table 1 on page 21). Use radiographic tests on 1 percent of the groove welds as selected by the QA Inspector. Do not conduct nondestructive testing on butt weld flanges and webs until they are cut to their full width.
- 8. Record all inspection results on the "Girder Inspection Form."

9. Record all ultrasonic inspection results on the "Ultrasonic Inspection Form." Use the letters "R," "R2," and "R3," after each weld number to indicate the number of repairs made.

Steel Construction: Fabrication - General Girder Inspection Procedures

Scope Statement

Conduct girder inspection procedures throughout the fabrication process. Recognize that when base metal is judged as damaged by the State because of faulty welding and/or removal for re-welding, the Contractor must either remove and replace the damaged base metal or compensate for the deficiency as approved by the Materials Engineer.

Quality Assurance performed by the Department may include verification of any or all steps marked "QA." Quality Assurance may order back-up radiographs as determined by the Materials Engineer.

Procedure

The G.I.R. functions as a project control document throughout general inspection procedures.

Document material and weld locations on the G.I.R.

Check all rod oven temperatures at least once a day.

Twice daily, check the shop to ensure that old welding electrodes are not used past their recommended atmospheric exposure time.

Prevent damage during handling of materials.

QC/QA

- 1. Locate each piece of steel in the main numbers (by heat number) on the "Girder Inspection Report" (G.I.R.).
- 2. Record the heat numbers.
- 3. Indicate compliance on each G.I.R. heat number with a check mark.
- 4. Measure the plates in the girder to verify correct placement.
- 5. Record the location of all groove welds. Ensure that no water, oil, etc., gets into the weld grooves.
- 6. Cross-check the G.I.R. to verify that all welds have been properly inspected. The Contractor is responsible for ensuring that all welds comply with the quality requirements of any specified nondestructive testing (other than visual testing.)
- 7. Indicate verification with a check mark.
- 8. Check the flux, wire-storage area.
- 9. Verify that a mechanical guide is used for all flame cutting, and that the specified surface roughness is obtained.

Steel Construction: Fabrication - Nondestructive Testing: Ultrasonic and Radiographic Inspection Scope Statement

Follow these procedures and standards for all ultrasonic inspection to meet the requirements of the Contract Documents, the AWS D1.5 Structural Welding Code, and the Materials Engineer.

Any variation in test procedure or equipment requires approval by the Materials Engineer.

Quality Assurance performed by the Department may include verification of any or all steps marked "QA." Quality Assurance may order back-up radiographs as determined by the Materials Engineer.

Procedure QC/QA

- 1. Perform all tests as specified in Ultrasonic Testing of Groove Welds (AWS D1.5) except that the acceptance/rejection criteria must agree with Table 1.
- 2. Ensure that ultrasonic inspection not performed by State employees, or an inspection agency under contract to the State, is witnessed by a representative of the State unless otherwise waived.
- 3. Perform all radiographic tests when required by the Engineer and in accordance with AWS D1.5 except that the acceptance/rejection criteria must agree with Table 1.
- 4. Use the ultrasonic acceptance/rejection criteria illustrated in Table 1.

Steel Construction: Fabrication -- Shop Assembly

Scope Statement

Ensure shop-assembly construction complies with the specifications.

Quality Assurance performed by the Department may include verification of any or all steps marked "QA." Quality Assurance may order back-up radiographs as determined by the Materials Engineer.

Procedure

Record data and inspection reports on the G.I.R.

QC/QA

- 1. Check the true camber in the girder to verify compliance within the specification tolerance.
 - Line up girder with pre-drilled splice plates and bearing stiffeners at right angles to the horizontal work line.
 - Stretch a wire from bearing stiffener to bearing stiffener.

- Place the wire on the designed camber at bearing stiffeners.
- Check the true camber at random locations between bearing stiffeners.
- Record the true camber on the G.I.R. (in parenthesis) below the design camber.
- 2. Check the overall distance between bearing stiffeners and the location of diaphragm stiffeners with a steel placed along the horizontal work line.
- 3. Check the roundness and location of the holes at the splice plates.
- 4. Match-mark the splice plates and girder to ensure ease of erection.
- 5. Verify stud welding quality operation by evaluating the sound made when each stud is tapped with a hammer.
 - If the sound is flat, bend the stud approximately 15 degrees by striking with a hammer.
 - Bend the stud in the opposite direction of any void that occurs because the weld around the base is incomplete.
 - Bend all studs that have been repaired.

Steel Construction: Fabrication -- Nondestructive Testing: Magnetic Particle Inspection

Scope Statement

Nondestructive testing, other than visual inspection, must be described in the Contract Documents and must designate the categories of welds to be examined, the extent of examination, and the method(s) of testing.

Subject magnetic particle inspection to these procedures and standards. Any variation in testing procedure or equipment requires approval by the Materials Engineer.

Perform all testing as specified in the Standard Method for Dry Powder Magnetic Particle Inspection (ASTM E-709) except that the part to be inspected must be magnetized using either the prod or yoke technique, as determined by the Materials Engineer. Only ferromagnetic materials can be tested by these techniques.

The Prod Technique passes an electric current between the prods to establish a localized circular magnetic field.

The Yoke Technique places the poles in contact with the part and energizes the coil of the electromagnet, establishing a longitudinal magnetic field.

Quality Assurance performed by the Department may include verification of any or all steps marked "QA." Quality Assurance may order back-up radiographs as determined by the Materials Engineer.

Procedure

Discontinuities are best detected when their major axis is normal to the magnetic lines of force.

Grinding may be required in the prod technique to provide proper electrical contact. Grinding may be required in either technique to remove surface irregularities that interfere with test interpretation.

Each report must list the test method, contract number, project identification number (PIN), county, test date, Fabricator's shop order number, and the erection mark. **QC/QA**

- 1. Use the prod technique to check for discontinuities with a major axis parallel to a line drawn between the two prods.
- 2. Use the yoke technique to check for discontinuities with a major axis normal to a line drawn between the two poles.
- 3. Ensure compliance with these prod technique provisions:
 - The magnetizing source produces direct or rectified half-wave direct current. Alternating current is not used as a magnetizing source.
 - The minimum magnetizing current is 400 amperes. Even though at least 100 amperes per inch of prod spacing is recommended, UDOT prefers a current density of 150 amperes per inch of prod spacing.
 - Arcing is controlled by proper testing techniques.
 - Aluminum prods are used instead of copper prods to perform magnetic particle inspection on ASTM A-588 steel or any steel with a minimum specified yield stress of 50 ksi or greater.
- 4. Ensure compliance with these yoke technique provisions:
 - The electromagnet operates on a 110-VAC, 60- cycle power supply and produces a pulsed DC- magnetic field.
 - The magnetic field strength produces a minimum 40-pound lifting force at the maximum pole spacing used.
 - An AC-magnetic field is not used.
- 5. Orient the prods or poles in two directions, approximately 90 degrees apart at each inspection point, to detect both longitudinal and transverse discontinuities.

- 6. Ensure 100 percent inspection of the areas to be tested by overlapping the prod or pole positions as the testing progresses.
- 7. Ensure that the surface being inspected is clean, dry, and free of oil, rust, loose mill scale, paint, and other coatings.
- 8. Ensure that welds subject to magnetic particle inspection have no cracks.
- 9. Evaluate porosity- and fusion-type defects as specified in the procedure standard (AWS D1.5).
- 10. Verify that the test technician prepares and signs a test report for each erection piece subject to inspection. The test report must identify the extent of the weld or base metal inspected, the name of the technician, the name of the State representative witnessing the work, and all indications of discontinuities.
- 11. Deliver a complete set of test reports to the Materials Engineer upon completion of the work.

Steel Construction: Fabrication--Nondestructive Testing: Dye Penetrant Inspection

Scope Statement

Ensure that all dye penetrant inspection conforms to these procedures and standards whenever required by the Contract Documents or ordered by the Engineer.

Limit the use of this inspection method to detecting discontinuities that are opened to the surface.

Perform penetrant tests only when the steel is between 40 and 110 degrees F.

Quality Assurance performed by the Department may include verification of any or all steps marked "QA." Quality Assurance may order back-up radiographs as determined by the Materials Engineer.

Procedure

QC/QA

- 1. Perform all testing as specified in Method B, "Visible Solvent, Removable Penetrant." ASTM E-165.
- 2. Clean the surface being inspected as specified. ASTM E-165.
- 3. Remove surface irregularities that interfere with the interpreting test results by grinding.

- 4. Smooth all welds by grinding prior to testing.
- 5. Ensure that all dye penetrant inspection not performed by State employees, or an inspection agency under contract to the State, is witnessed by a representative of the State.
- 6. Verify that the test technician prepares a report for each erection piece subject to inspection. Ensure that the report identifies the extent of the weld or base metal inspected, the name of the technician (printed and signed), the name of the State representative witnessing the work, and all indications of discontinuities.
- 7. Ensure that each report lists the project number, project authority number, project name, county, date of test, Fabricator's shop order number, and erection mark.
- 8. Deliver a complete set of test reports to the Materials Engineer upon completion of the work.
- 9. Ensure that welds subject to dye penetrant inspection have no cracks.
- 10. Evaluate porosity- and fusion-type defects as specified in the procedure standard (AWS D1.5).